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Coudurier

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(54) **SPLICING OF VIDEO FOR PARALLEL ENCODING**

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(52) **U.S. Cl.**
CPC ***H04N 19/436*** (2014.11)

(58) **Field of Classification Search**
CPC H04N 19/436
USPC 375/240.26
See application file for complete search history.

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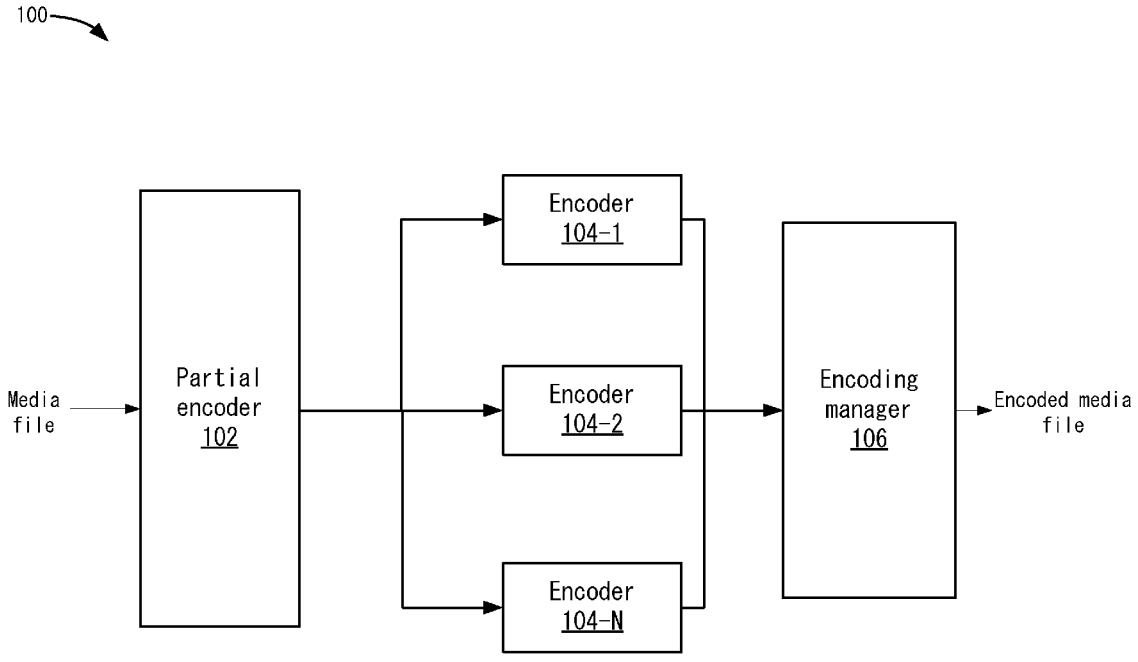
(57) **ABSTRACT**

In one embodiment, a method receives a video at a partial encoder. The partial encoder determines characteristics of the video by performing a portion of an encoding process of the video. The method analyzes the characteristics of the video to determine splice points in the video to splice the video into multiple parts. The video is spliced into a plurality of parts based on the splice points and the plurality of parts are sent to a plurality of encoders. The plurality of encoders encode the plurality of parts substantially in parallel, the encoded plurality of parts are combined to form an encoded version of the video, and the partial encoder does not encode any of the encoded plurality of parts in the encoded version of the video.

19 Claims, 4 Drawing Sheets



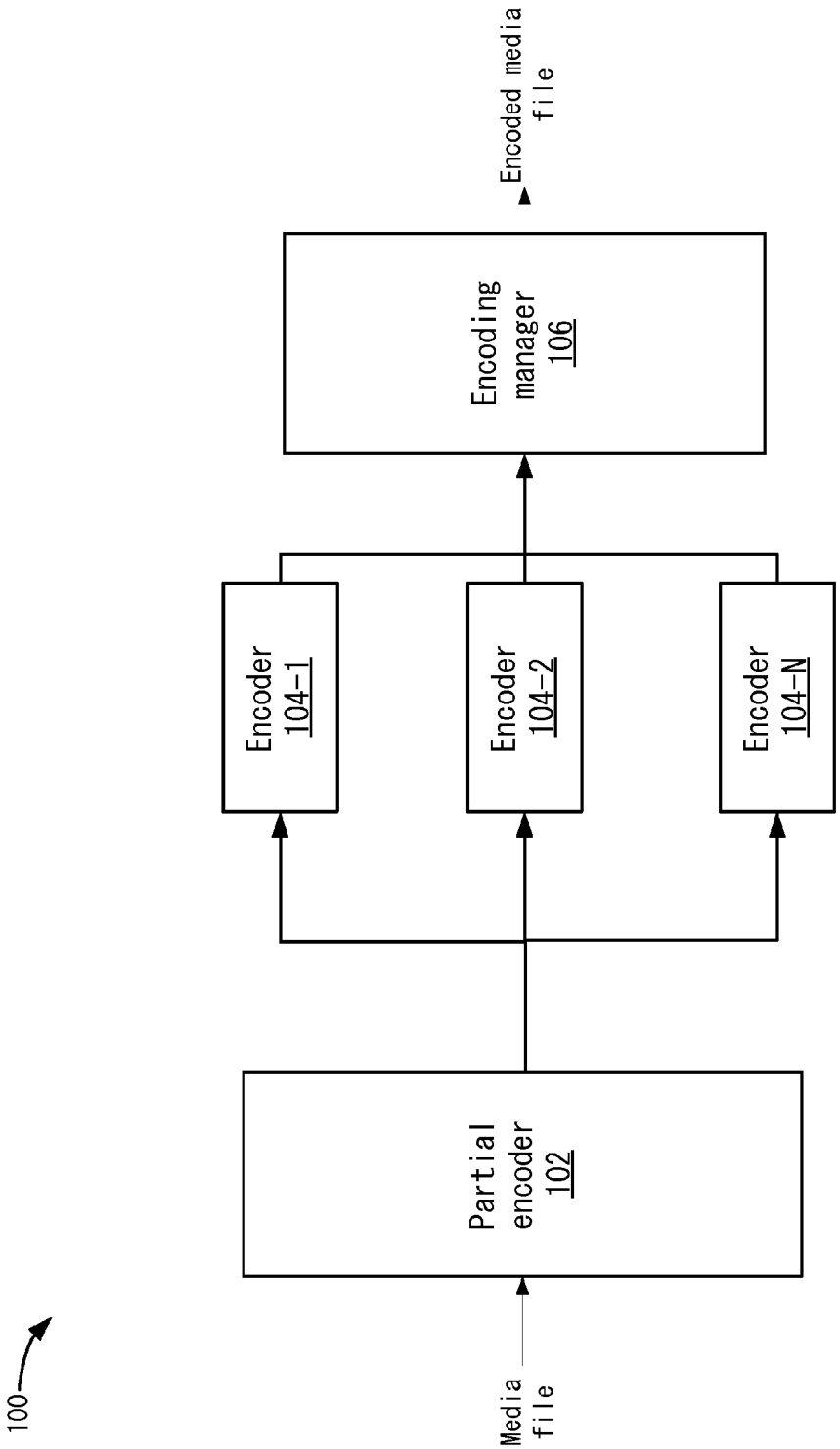

Encoded media file
Encoding manager 106
Encoder 104-1
Encoder 104-2
Encoder 104-N
Partial encoder 102
Media file
100

FIG. 1

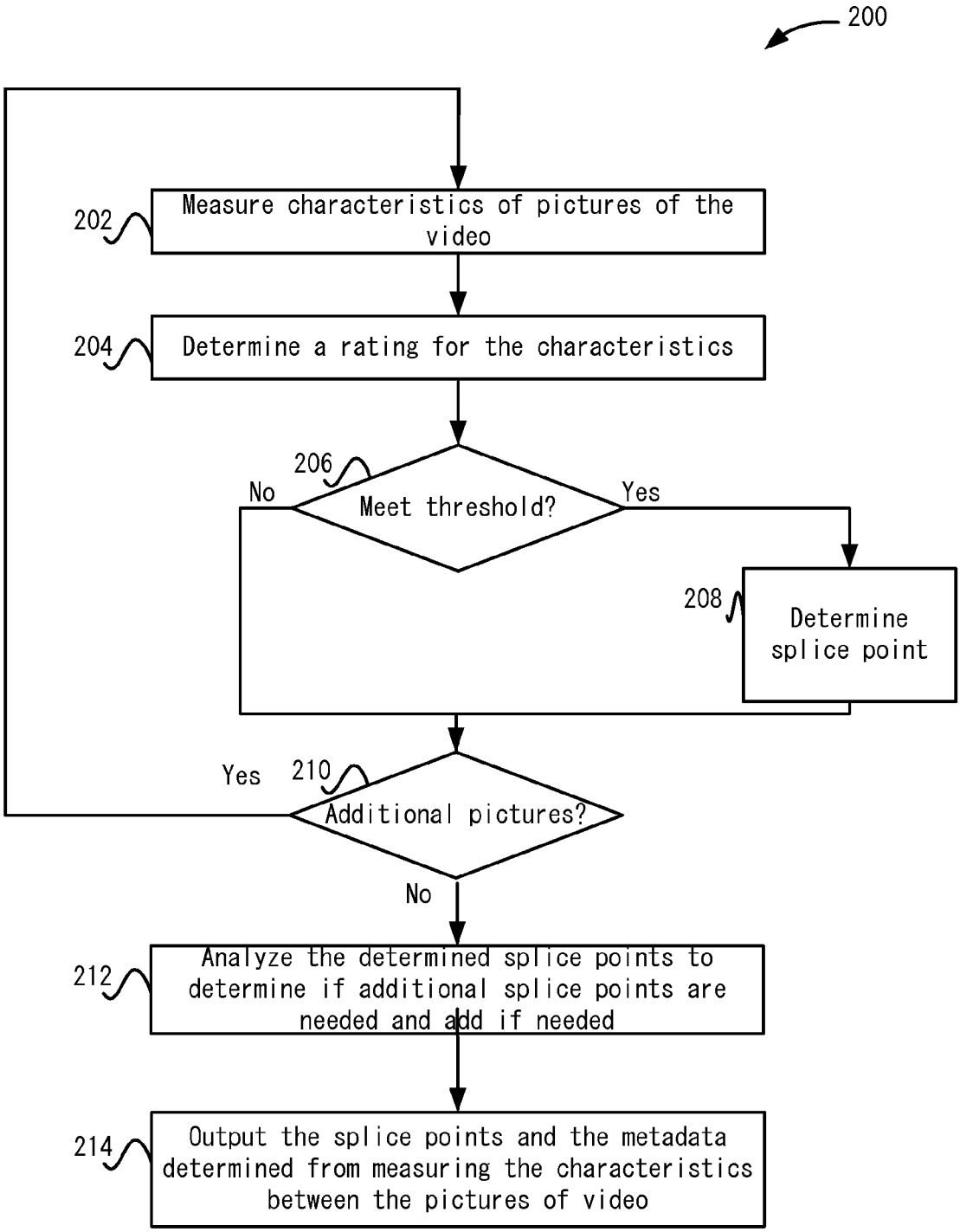

200
202
Measure characteristics of pictures of the video
204
Determine a rating for the characteristics
206
Meet threshold?
No
Yes
208
Determine splice point
210
Additional pictures?
Yes
No
212
Analyze the determined splice points to determine if additional splice points are needed and add if needed
214
Output the splice points and the metadata determined from measuring the characteristics between the pictures of video

FIG. 2

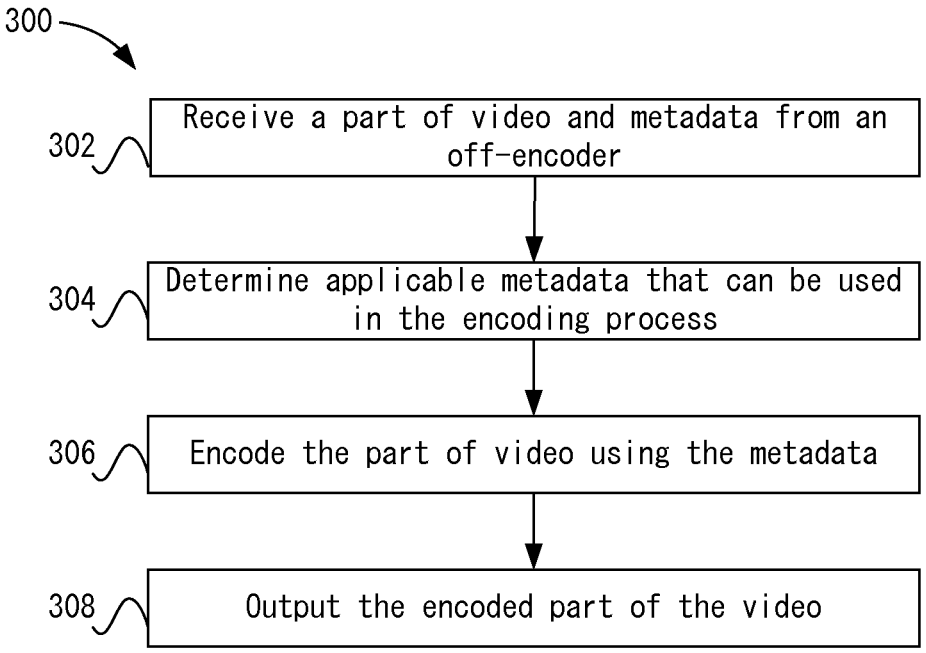

300
302
Receive a part of video and metadata from an off-encoder
304
Determine applicable metadata that can be used in the encoding process
306
Encode the part of video using the metadata
308
Output the encoded part of the video

FIG. 3

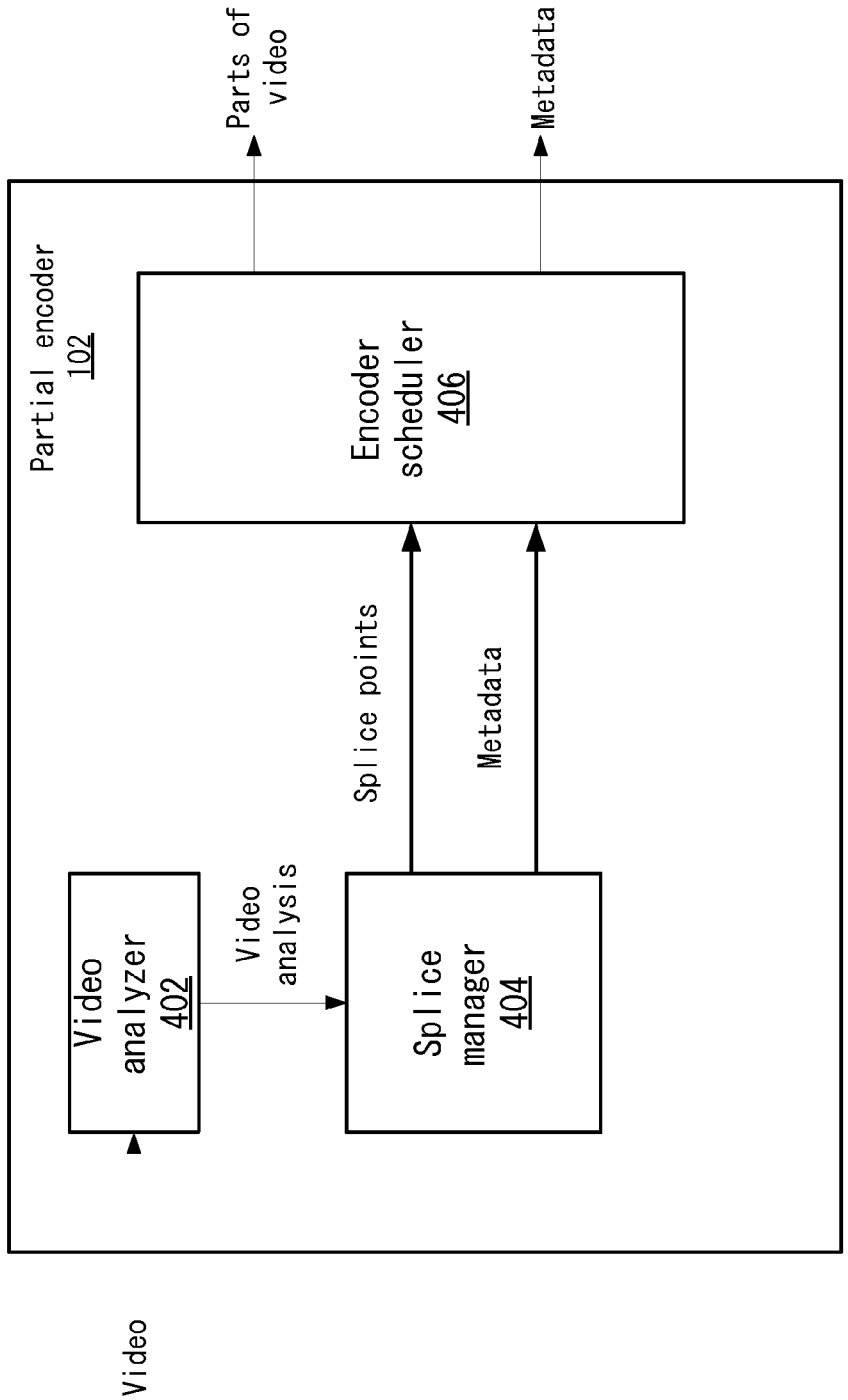

Parts of video
Metadata
Partial encoder 102
Encoder scheduler 406
Splice points
Metadata
Video analyzer 402
Video analysis
Splice manager 404
Video

FIG. 4

SPLICING OF VIDEO FOR PARALLEL ENCODING

BACKGROUND

Media programs, including audio-video data, are increasingly distributed over telecommunications networks for the viewing and enjoyment of users. Services provide media programs to users through various video delivery technologies (e.g., streaming). For example, the service may allow a user to view the latest television shows or movies through a web portal using a media player. After a television show airs, the service may experience a high demand for the television show. In one example, a media program provider provides the television show to the service. The service then needs to transcode the television show before the service can make the television show available to the users. For example, the television show may need to be transcoded into different bitrates. Due to the popularity of the video, the service would like to transcode the media program as fast as possible. However, if the transcoding is performed by one encoder, the service must wait until the encoder finishes transcoding the entire television show to before making the television show available to users.

One way of transcoding the media program faster is to splice the media program into multiple parts and transcode the media program using multiple encoders. Thus, the encoding can be performed in parallel and the encoded parts from the encoders are combined into a file. Typically, the splicing of the media program into multiple parts is performed based on time. For example, the media program may be spliced every 5 seconds. This may encode the media program faster, but the splicing may not be optimal because encoding a picture of video depends on other parts of the video. For example, motion estimation and motion compensation leverage the use of already encoded pictures, such as reference pictures. If arbitrary splices are used, then one part of video that is sent to one encoder may not be optimal because references pictures that should be encoded with pictures of that part may have been sent to another encoder.

SUMMARY

In one embodiment, a method receives a video at a partial encoder. The partial encoder determines characteristics of the video by performing a portion of an encoding process of the video. The method analyzes the characteristics of the video to determine splice points in the video to splice the video into multiple parts. The video is spliced into a plurality of parts based on the splice points and the plurality of parts are sent to a plurality of encoders. The plurality of encoders encode the plurality of parts substantially in parallel, the encoded plurality of parts are combined to form an encoded version of the video, and the partial encoder does not encode any of the encoded plurality of parts in the encoded version of the video.

In one embodiment, a non-transitory computer-readable storage medium is provided containing instructions, that when executed, control a computer system to be configured for: receiving a video at a partial encoder; determining, by the partial encoder, characteristics of the video, the characteristics determined by performing a portion of an encoding process of the video; analyzing the characteristics of the video to determine splice points in the video to splice the video into multiple parts; splicing the video into a plurality of parts based on the splice points; and sending the plurality of parts to a plurality of encoders, wherein: the plurality of encoders encode the plurality of parts substantially in parallel, the encoded plurality of parts are combined to form an encoded version of the video, and the partial encoder does not encode any of the encoded plurality of parts in the encoded version of the video.

In one embodiment, an apparatus is provided comprising: one or more computer processors; and a computer-readable storage medium comprising instructions, that when executed, control the one or more computer processors to be configured for: receiving a video; determining characteristics of the video, the characteristics determined by performing a portion of an encoding process of the video; analyzing the characteristics of the video to determine splice points in the video to splice the video into multiple parts; splicing the video into a plurality of parts based on the splice points; and sending the plurality of parts to a plurality of encoders, wherein: the plurality of encoders encode the plurality of parts substantially in parallel, the encoded plurality of parts are combined to form an encoded version of the video, and the determining of the characteristics does not encode any of the encoded plurality of parts in the encoded version of the video.

The following detailed description and accompanying drawings provide a better understanding of the nature and advantages of particular embodiments.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** depicts a simplified system for encoding a media program according to one embodiment.

FIG. **2** depicts a simplified flowchart of a method for determining splice points according to one embodiment.

FIG. **3** depicts a simplified flowchart of a method for encoding the multiple parts of video in parallel according to one embodiment.

FIG. **4** depicts a more detailed example of a partial encoder according to one embodiment.

DETAILED DESCRIPTION

Described herein are techniques for an encoding system. In the following description, for purposes of explanation, numerous examples and specific details are set forth in order to provide a thorough understanding of particular embodiments. Particular embodiments as defined by the claims may include some or all of the features in these examples alone or in combination with other features described below, and may further include modifications and equivalents of the features and concepts described herein.

FIG. **1** depicts a simplified system **100** for encoding a media program according to one embodiment. As discussed above, a service may provide media programs to users. In one example, it is desirable to have media programs available to the users as fast as possible. However, the media program needs to be encoded, sometimes into multiple bitrates, before it can be made available for viewing, such as on the website. Thus, particular embodiments provide parallel encoding of the media program. To more efficiently encode the media program, particular embodiments analyze the video of the media program to determine splice points that are optimal and use the splice points to split the video into multiple parts. The multiple parts can then be encoded in parallel. The encoded parts are then combined into a file.

A partial encoder **102** receives a media file for a media program. The media file includes video that needs to be encoded. Partial encoder **102** analyzes the video to determine splice points and additional metadata that may be used in encoding the video. However, partial encoder **102** may not perform encoding of the video. Rather, partial encoder **102**

may perform operations that may be a portion of an encoding process to determine splice points where the video is spliced. For example, as will be described in more detail below, partial encoder **102** analyzes differences in pictures of the video to determine where to splice the video. For example, partial encoder **102** determines a sum of squared differences or sum of absolute differences for pictures of the video.

The splice points that partial encoder **102** determines are then used to splice the video into multiple parts. The multiple parts can then be encoded in parallel by encoders **104-1**, **104-2**, . . . , **104**-N. Encoders **104** receive different parts of the video and encode each part separately. The encoding may be performed in parallel, which may speed up the encoding process as compared to encoding the entire video in series with an encoder.

Encoders **104** may also receive metadata that was determined by partial encoder **102**. For example, because partial encoder **102** performed a part of the encoding process, encoders **104** may not need to perform this process again. For example, part of the encoding process (e.g., in motion estimation and motion compensation) is to determine differences between pictures of the media program. Encoders **104** may not need to determine these differences again. Rather, encoders **104** use the differences determined by partial encoder **102** to make encoding decisions during the encoding process.

When finished encoding each part, encoders **104** output the encoded part to an encoding manager **106**. Encoding manager **106** can then assemble the encoded parts into a media file. For example, the encoded parts may be merged into one file. Encoding manager **106** then outputs the file. The above process may be repeated to encode the video into multiple bitrates.

FIG. **2** depicts a simplified flowchart **200** of a method for determining splice points according to one embodiment. At **202**, partial encoder **102** measures characteristics of pictures of the video. A picture may be a unit of video content. Other units of video content may also be appreciated or referred to, such as frames, blocks, etc. The characteristics that are measured may include differences between pictures in the video. For example, when an object is moving, differences result in pictures due to the movement.

The differences may be reflected by movement of objects in the video. The differences may be measured because it may be desirable to have a splice point when many differences result. For example, during a scene change, there may be many differences as the scene changes from one setting to another setting. This may be a good point to have a splice point because an encoding process may not be able to leverage many similarities in the pictures because of the differences. Thus, the two parts that are formed by the splice point may be sent to different encoders **104**. However, if many differences do not result between two pictures, then this point may not be a good splice point because an encoding process may exploit the similarities between the two pictures. For example, in an encoding process, the differences between the similar pictures are encoded and sent. This improves compression of the video and makes the encoding process more efficient. Thus, it is desirable to encode similar pictures together. However, the efficiency is not as affected when the splice point is between pictures with large differences because not as many similarities can be exploited.

At **204**, partial encoder **102** determines a rating for the characteristics. For example, depending on the amount of differences between the pictures, a rating may be determined, such as pictures with a higher difference are rated higher than pictures with a lower difference. Other characteristics may be taken into account when determining the rating.

At **206**, partial encoder **102** determines if the rating meets a threshold. The threshold is used to determine if splice points should be inserted in the video. For example, if the rating meets the threshold, then at **208**, partial encoder **102** determines that a splice point should be inserted between the pictures of the media program. In this case, this may indicate the differences between the units of video are enough that it makes sense to put a splice point between the pictures.

If the threshold is not met, or after a splice point is determined, at **210**, partial encoder **102** determines if additional pictures should be processed. If so, the process reiterates to **202** to measure additional characteristics between other pictures of the video. For example, partial encoder **102** may sequentially analyze pictures of the video. Also, the analysis may be performed using multiple pictures, such as more than two pictures may be analyzed or differences from non-consecutive pictures may be determined

If there are no more pictures to process, at **212**, partial encoder **102** analyzes the determined splice points to determine if additional splice points are needed. For example, the splice points may result in parts that may be longer than desired. For example, a scene may be long and thus the part is longer than desired. In this case, additional splice points may be inserted to reduce the length of some parts. If the additional splice points are not added, then some parts of the video may be sent to encoders **104** that are much longer than others, which may increase the encoding time because some encoders **104** may take longer than other encoders to encode their parts of video.

When the entire video has been analyzed, at **214**, partial encoder **102** outputs the splice points and the metadata determined from measuring the characteristics between the pictures of video. For example, partial encoder **102** outputs the splice points and metadata to encoders **104**. Also, the splice points and metadata can be output to a scheduler that schedules the encoding of the video.

FIG. **3** depicts a simplified flowchart **300** of a method for encoding the multiple parts of video in parallel according to one embodiment. At **302**, an encoder **104** receives a part of video and metadata from partial encoder **102**. For example, encoder **104** receives only the part of video that encoder **104** is to encode. The other parts of video are sent to other encoders **104** and the present encoder **104** does not have knowledge of what information is in the other parts. Thus, the encoding process is performed solely on the part of video that is received.

At **304**, encoder **104** determines applicable metadata that can be used in the encoding process. For example, the encoding process may need to determine the differences between units of video that are being encoded for motion compensation or motion estimation. Because these differences have been computed before by partial encoder **102**, encoder **104** does not need to perform these calculations again.

At **306**, encoder **104** encodes the part of video using the metadata. Encoder **104** may make different decisions in encoding the part of the video by using the metadata. For example, if partial encoder **102** performs motion estimation, encoder **104** may use the motion estimation decision during the encoding process. In this case, partial encoder **102** may save the motion estimation decision. Encoders **102** would then retrieve applicable motion estimation decisions when encoding the parts of the video. For example, for a unit of video that is being encoded, the motion estimation decision that was determined by partial encoder **102** is used by encoder **102** instead of making the motion estimation decision again.

At **308**, encoder **104** outputs the encoded part of the video. Encoding manager **106** then receives the encoded parts of

video from multiple encoders **104** and combines the multiple parts into one file. Each part may be identified and encoding manager **106** combines the parts into the correct input sequence.

FIG. **4** depicts a more detailed example of partial encoder **102** according to one embodiment. A video analyzer **402** receives the video. Video analyzer **402** can then analyze the characteristics of the video as discussed above. For example, video analyzer **402** may be an encoder where only a part of the encoder is used. For example, the differences are measured by the encoder, but encoding of the video is not performed. In one example, the encoder is only programmed to determine the differences between pictures of the video.

Video analyzer **402** then outputs the characteristics of the video to a splice manager **404**. Splice manager **404** then determines where splice points should be determined For example, splice manager **404** may determine ratings for the differences determined and determine whether a splice point should be inserted between pictures of the video. Splice manager **404** outputs the splice points and metadata. For example, the metadata may be the characteristics that were determined by video analyzer **402** or any analysis by splice manager **404**, such as the ratings.

An encoder scheduler **406** then splits the video into multiple parts and schedules the encoding of the multiple parts on encoders **104**. Encoder scheduler **406** may also determine applicable metadata for each part of video and send the applicable metadata with each part to each encoder **104**. In other embodiments, the entire set of metadata may be sent to each encoder **104**.

Accordingly, partial encoder **102** is used to analyze characteristics of the video before a parallel encoding process. This optimizes the splice points of the video. Thus, the multiple parts of video that are sent to different encoders **104** may be encoded more efficiently and also faster.

Particular embodiments may be implemented in a non-transitory computer-readable storage medium for use by or in connection with the instruction execution system, apparatus, system, or machine. The computer-readable storage medium contains instructions for controlling a computer system to perform a method described by particular embodiments. The instructions, when executed by one or more computer processors, may be operable to perform that which is described in particular embodiments.

As used in the description herein and throughout the claims that follow, "a", "an", and "the" includes plural references unless the context clearly dictates otherwise. Also, as used in the description herein and throughout the claims that follow, the meaning of "in" includes "in" and "on" unless the context clearly dictates otherwise.

The above description illustrates various embodiments along with examples of how aspects of particular embodiments may be implemented. The above examples and embodiments should not be deemed to be the only embodiments, and are presented to illustrate the flexibility and advantages of particular embodiments as defined by the following claims. Based on the above disclosure and the following claims, other arrangements, embodiments, implementations and equivalents may be employed without departing from the scope hereof as defined by the claims.

What is claimed is:

1. A method comprising:

receiving a video at a partial encoder, the partial encoder programmed to only perform a portion of an encoding process of the video;

determining, by the partial encoder, characteristics of the video to determine differences between the pictures in the video, the characteristics determined by performing the portion of the encoding process of the video;

analyzing the differences between pictures in the video to determine ratings for a plurality of potential splice points in the video;

comparing the ratings between pictures to a threshold;

selecting splice points from a subset of the plurality of potential splice points based on the comparing, wherein a splice point is selected when a rating between pictures meets the threshold;

splicing the video into a plurality of parts based on the splice points; and

sending the plurality of parts to a plurality of encoders, wherein:

the plurality of encoders encode the plurality of parts substantially in parallel,

the encoded plurality of parts are combined to form an encoded version of the video, and

the partial encoder does not encode any of the encoded plurality of parts in the encoded version of the video.

2. The method of claim **1**, wherein:

the plurality of encoders include a first encoder and a second encoder,

the first encoder encodes a first part in the plurality of parts and the second encoder encode a second part in the plurality of parts, and

the first part and the second part are different parts of the video.

3. The method of claim **2**, wherein:

the first encoder does not have knowledge of information in the second part to use in encoding the first part, and

the second encoder does not have knowledge of information in the first part to use in encoding the second part.

4. The method of claim **1**, wherein each part in the plurality of parts is sent to a separate encoder to encode each part in parallel.

5. The method of claim **1**, wherein analyzing the differences between pictures in the video comprises:

determining where a possible scene change occurs in the video; and

adding a potential splice point at the scene change.

6. The method of claim **1**, further comprising:

determining additional splice points not found in the selected splice points; and

adding the additional splice points.

7. The method of claim **1**, wherein:

the threshold comprises a first threshold, and

the additional splice points not found in the selected splice points are determined when parts are longer than a second threshold.

8. The method of claim **1**, wherein the plurality of encoders use the characteristics determined by the partial encoder to encode the plurality of parts.

9. A non-transitory computer-readable storage medium containing instructions, that when executed, control a computer system to be configured for:

receiving a video at a partial encoder, the partial encoder programmed to only perform a portion of an encoding process of the video;

determining, by the partial encoder, characteristics of the video to determine differences between pictures in the video, the characteristics determined by performing the portion of the encoding process of the video;

analyzing the differences between pictures in the video to determine ratings for a plurality of potential splice points in the video;

comparing the ratings between pictures to a threshold;

selecting splice points from a subset of the plurality of potential splice points based on the comparing, wherein a splice point is selected when a rating between pictures meets the threshold;

splicing the video into a plurality of parts based on the splice points; and

sending the plurality of parts to a plurality of encoders, wherein:

the plurality of encoders encode the plurality of parts substantially in parallel,

the encoded plurality of parts are combined to form an encoded version of the video, and

the partial encoder does not encode any of the encoded plurality of parts in the encoded version of the video.

10. The non-transitory computer-readable storage medium of claim **9**, wherein:

the plurality of encoders include a first encoder and a second encoder,

the first encoder encodes a first part in the plurality of parts and the second encoder encode a second part in the plurality of parts, and

the first part and the second part are different parts of the video.

11. The non-transitory computer-readable storage medium of claim **10**, wherein:

the first encoder does not have knowledge of information in the second part to use in encoding the first part, and

the second encoder does not have knowledge of information in the first part to use in encoding the second part.

12. The non-transitory computer-readable storage medium of claim **9**, wherein each part in the plurality of parts is sent to a separate encoder to encode each part in parallel.

13. The non-transitory computer-readable storage medium of claim **9**, wherein analyzing the differences between pictures in the video comprises:

determining where a possible scene change occurs in the video; and

dding a splice point at the scene change.

14. The non-transitory computer-readable storage medium of claim **9**, wherein analyzing the characteristics of the video comprises:

determining differences between pictures in the video to determine the ratings;

comparing the ratings between pictures to a threshold; and

selecting a splice point when a rating between pictures is greater than the threshold.

15. The non-transitory computer-readable storage medium of claim **9**, further configured for:

determining additional splice points not found in the selected splice points; and

adding the additional splice points.

16. The non-transitory computer-readable storage medium of claim **9**, wherein the additional splice points not found in the selected splice points are determined when parts are longer than a threshold.

17. The non-transitory computer-readable storage medium of claim **9**, wherein the plurality of encoders use the characteristics determined by the partial encoder to encode the plurality of parts.

18. An apparatus comprising:

one or more computer processors; and

a computer-readable storage medium comprising instructions, that when executed, control the one or more computer processors to be configured for:

receiving a video at a partial encoder, the partial encoder programmed to only perform a portion of an encoding process of the video;

determining, by the partial encoder, characteristics of the video to determine differences between pictures in the video, the characteristics determined by performing the portion of the encoding process of the video;

analyzing the differences between pictures in the video to determine ratings for a plurality of potential splice points in the video;

comparing the ratings between pictures to a threshold;

selecting splice points from a subset of the plurality of potential splice points based on the comparing wherein a splice point is selected when a rating between pictures meets the threshold;

splicing the video into a plurality of parts based on the splice points; and

sending the plurality of parts to a plurality of encoders, wherein:

the plurality of encoders encode the plurality of parts substantially in parallel,

the encoded plurality of parts are combined to form an encoded version of the video, and

the partial encoder does not encode any of the encoded plurality of parts in the encoded version of the video.

19. The apparatus of claim **18**, wherein:

the plurality of encoders include a first encoder and a second encoder,

the first encoder encodes a first part in the plurality of parts and the second encoder encode a second part in the plurality of parts, the first part and the second part are different parts of the video,

the first encoder does not have knowledge of information in the second part to use in encoding the first part, and

the second encoder does not have knowledge of information in the first part to use in encoding the second part.

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UNITED STATES PATENT AND TRADEMARK OFFICE

CERTIFICATE OF CORRECTION

PATENT NO. : 9,307,261 B2
APPLICATION NO. : 13/584065
DATED : April 5, 2016
INVENTOR(S) : Baptiste Coudurier

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

In the Claims

In column 7, claim 10, line 20, please delete "encode" and insert --encodes--.

In column 7, claim 13, line 38, please delete "dding" and insert --adding--.

In column 8, claim 19, line 44, please delete "encode" and insert --encodes--.

Signed and Sealed this
Fourteenth Day of June, 2016

Michelle K. Lee

Michelle K. Lee
Director of the United States Patent and Trademark Office